Response to Comment for "An evaluation of global organic aerosol schemes using airborne observations"

Thank you for your comments. We have responded to them below (in red)

Line 126-132 and Line 152-155: It seems to me that 'OCPI' in Simple SOA scheme and 'OPOA' in Complex SOA scheme are both called as "OPOA" in this paper. Because OCPI represents non-volatile hydrophilic OC and OPOA represents semi-volatile products of SVOC oxidation, they are very different. It might be better not to confuse readers about that.

We have added more information to the main-text and to the supplemental material to provide greater detail on the differences between OPOA treatment in the simple and complex schemes to prevent any confusion. The simple scheme parameterization of OCPO to OCPI is intended to broadly capture the aging of primary OA and is not linked explicitly to heterogeneous chemistry or partitioning. We have thus chosen to use OPOA to refer to both 'simple OCPI' and 'complex OPOA' because they are both intended to represent aged primary OC.

Line 155-159: OPOA seemed being classified as POA in this paper. However, in Pye et al. [2010] and related field and lab studies, OPOA is regarded as SOA. Please clarify.

The OPOA product is formed by the oxidation of EPOA. In the simple scheme, this process is approximated by a fixed lifetime of 1 day with no direct dependence on oxidant concentrations. In the complex scheme, EPOA is oxidized with OH to form oxygenated primary organic vapors. Many previous studies in the literature have represented the aerosol formed from these vapors as Oxygenated POA (Donahue et al., 2009; Pye et al., 2010; Shrivastava et al., 2008) but the nomenclature has been the topic of some contention, with other studies preferring to use the terminology of Secondary Organic Aerosol (SOA) to represent this aerosol product (Hayes et al., 2015; Murphy et al., 2014). For the purpose of this study we have chosen to refer to aerosol resulting from the oxidation of primary organic matter that is already semi-volatile as OPOA and reserve the term SOA exclusively for aerosol formed from the oxidation of volatile organic vapors. We are further motivated to maintain the OPOA label given that this is how it is described in the GEOS-Chem model and the relevant model paper (Pye et al., 2010). We have separated the OPOA contribution and discussion whenever possible in this study to allow the reader to interpret the results as desired and have also added a detailed discussion to the SI.

Line 210-212: Large differences between the two schemes in Figure 2 occur in highly polluted areas like China and India. The northeastern US show similar differences. Is it possible to use surface measurements from, for example, the IMPROVE datasets to evaluate the model performance in polluted areas?

We chose to limit our analysis to aircraft observations for a few different reasons. Ground networks are only available in a few locations (US and Europe) and these networks use different instrumentation; our goal was to use consistent AMS measurements. We could have used globally distributed AMS observations, such as in Jimenez et al., 2009, however comparisons of global models with surface sites

are more susceptible to representation errors and sub-grid meteorology that are both challenging to address. We specifically designed the study to focus on the regional constraints offered by airborne measurements around the world that sample OA under a range of conditions. Since health impacts are not the focus of this work (i.e. we do not focus on surface concentrations or exposures), observational exploration throughout the full troposphere seemed best suited for exploring the OA budget. We commented on the need for airborne measurements in these regions in our conclusions.

Line 346: Why are the pristine areas in the Canadian Arctic and Greenland classified as the anthropogenic regime in Figure 5?

We have modified the main-text to explicitly state that our classification of anthropogenic OA (and indeed all other categories) includes both 'fresh' and 'aged' regions. With regards to the North Pacific, we track much of that pollution to east Asian emissions from China and the surrounding countries, while the North Atlantic is influenced by both European and African emissions.

Line 398-399: I don't think that the consistent differences are caused by inaccurate emission inventories only. How about the lacked aging processes and the different abilities to reproduce ASOA and BSOA in the two schemes?

We do not imply that these differences are exclusively due to inaccurate emissions inventories but only that they likely play an important role. We have included various other contributing factors in the main-text.

Line 513: I am confused that in Figure S7, the Complex POA + Simple SOA simulation shows lower OA concentrations than other combinations in the anthropogenic regime. Because the Complex POA + Simple SOA double-counts the contribution from SVOC oxidation to OA, the concentrations should be overestimated.

The complex POA consists of EPOA, OPOA and MPOA while the simple SOA consists of ASOA, ISOA, TSOA and FSOA. In the case referred to above, the OA resulting in the oxidation of SVOCs (represented in the model as primary organic gases – POGs and oxidized POGs) is only represented in the complex POA and is not included in the simple ASOA component.